

language or refined rhapsodies on rural life and scenes, but in natural vigorous words Bettesworth—that was the name of the labourer—gives his opinion upon sundry persons, places and things he has known. The ethnographer will here and there find descriptions of country customs and remedies which will interest him.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Relative Velocity in Streams.

IN your review of the report of M. Vallot from his observatory on Mont Blanc (p. 31) you speak of his finding that a stream ceases to increase in speed in a channel of greater incline than 3 in 100 as something unexpected.

For more than twenty years I have contended, in repeated publications, that friction against the bed increasing progressively from the middle to the margin divides every stream longitudinally into two halves, which roll spirally toward each other. This spiral being determined by the friction, its helix rises with the speed, or the increased friction depending on the speed, which in turn depends on the slope of the channel. It follows that beyond a certain speed the stream loses all the momentum gained by its fall in beating with the two outward-moving undercurrents against the channel walls. In this way the stream attains its kinetic equilibrium. If glaciers are plastic or viscous bodies, they, too, must obey the same laws.

Louisville, Kentucky, U.S.A.

D. T. SMITH.

Change of Pitch of Certain Sounds with Distance.

IN NATURE of December 12 (p. 129), Mr. F. M. West describes an observation made while walking up and down the platform of a railway station. The pitch of the sound caused by the steam escaping from an engine rose as he retreated from it and fell as he drew near to it.

As I gave the explanation of the same phenomenon in *Les Archives Néerlandaises* (Arch. Néerl. Livre jubilaire, November 1901), I may be permitted to give a summary in these pages.

The pitch will not only rise by retreating from the engine, but also by bringing the ear nearer to the ground. The pitch is due to reflection of the sound from the platform itself, for when a large board is laid down on the ground between the engine and the observer, the pitch will be heard to rise when the board is raised.

It is clear, therefore, that the pitch can be caused by interference of the direct and the reflected sound-waves, a phenomenon wholly similar to Lloyd's experiment with light-waves. As in Lloyd's experiment the elementary colours of the white light are separated in space, so here the different pitches of sound will predominate in different points of space, and a sort of sound-spectrum will be formed.

A mathematical examination enables us to analyse the irregular vibration of a noise during a short time, according to Fourier, into a series of harmonic vibrations. Moreover, it can be proved by calculation that the interference of the direct and the reflected sound-waves must cause at any spot a series of (impure) pitches to be heard. The wave-lengths of these pitches must be $1/1$, $1/2$, $1/3$. . . of the difference of distance travelled over by both sounds.

An experimental examination, made at the platform of a railway station, has shown me that the pitch of the noise of an engine fully agrees with the theory, so far as the impurity of the pitch permitted an exact experiment to be made.

When the noise of a waterfall or rustling trees is perpendicularly reflected by a wall, Baumgarten has observed the change of pitch in the vicinity of this wall (Müller-Pouillet, "Lehrbuch der Physik," i. p. 732). The above-mentioned result is also applicable in this case. In the neighbourhood of a waterfall I obtained experimental results perfectly agreeing with theory.

D. VAN GULIK.

Apeldoorn, December 15.

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CHEMICAL INSTRUCTION AND CHEMICAL INDUSTRIES IN GERMANY.

JUST now, when men of science and educationists are continually directing attention to the superiority of German educational and industrial methods, especially in the domain of chemistry, a report published among the "Miscellaneous Series" of the Foreign Office is most apposite, and should be studied by all who are truly interested in the educational and commercial welfare of the nation.

The object of the report, which is compiled by Dr. Frederick Rose, His Majesty's Consul at Stuttgart, is "to show to what extent the German chemical industries have benefited by the sums expended by the German States on chemical instruction." A perusal of the contents of this highly interesting and instructive report shows us that the German technical high schools or polytechnics differ *in toto* from those of the United Kingdom. They are, in fact, more like our University colleges, *e.g.* Owens College and Mason College (new University of Birmingham). The older Universities in Germany began to study chemical technology about the middle of the seventeenth century. They thus laid the foundation-stone of the present-day industrial chemistry for which the country has become famous. As trade and chemical industries gradually advanced, the Universities were found inadequate to train the greatly increased number of chemists who were required. The polytechnics (now called technical high schools) were consequently founded. These are, without exception, products of the nineteenth century. One must not, however, lose sight of the fact that it is only within the last two generations that the technical high schools have assumed such prominence. They had first to learn what was required of them if they were to exert a really beneficial effect upon the welfare of the country. On p. 8 of the report the following words appear, which we trust some of our technical educationists will take to heart:—

"The study of architecture, engineering and chemistry at the technical high schools left, at the beginning, much to be desired, as the erroneous opinion prevailed that it was not necessary for the students to devote themselves to the study of scientific works, but rather to acquire a certain practical aptitude in superficial manipulation. . . . Later on, however, it was clearly perceived that the scientific foundation laid during the scientific courses at the technical high schools formed the soundest basis for the practical experience to be gained during professional life."

In the British polytechnics the teaching staff have no social status, and the scale of remuneration depends entirely upon the governing body, who have usually great difficulty in making both ends meet. But in the Prussian technical high schools, which are under the direct control of the State, the members of the professional staff possess the rank of full State officials, and the salaries are regulated according to certain fixed limits. Indeed, so deeply is the German Emperor convinced of the importance of technical education that he has caused the directors of the Prussian technical high schools to be admitted to the Prussian Upper House, while a short time ago at the centenary of the Berlin Technical High School he conferred upon the Prussian technical high schools the right to confer a new degree of Doctor of Engineering, thus practically raising the technical schools to the level of the Universities.

Before the students are allowed to pass into the technical high schools they must show that they have obtained a preliminary education of a very high order. Whilst it is no unusual thing in our polytechnics to find students who have absolutely no knowledge of the merest elements of arithmetic and who are quite unable

to enter the results of their experimental work in an intelligible manner, such students could not enter the German technical high schools.

Students of chemistry who enter the technical high schools do not devote the whole of their time to chemistry; they take out a full technological course, including such subjects as trigonometry, higher mathematics, physics, botany, electrotechnics, technical drawing, machine drawing, &c. The above subjects have been taken at random from the syllabus of the Darmstadt Technical High School for 1895. Perhaps, however, the thoroughness of the courses through which the student must pass before obtaining his technological diploma is best shown by a study of the syllabus of the Stuttgart Technical High School.

Subject	Number of hours per week					
	1st year		2nd year		3rd year	
	Summer term	Winter term	Summer term	Winter term	Summer term	Winter term
Mineralogy and geology ...	4	5	—	5	—	—
Zoology	3	3	—	—	—	—
Botany	—	—	3	6	—	—
Physics	4	4	—	—	—	—
Experimental chemistry ...	4	4	—	—	—	—
Theoretical chemistry ...	—	4	—	—	—	—
Analytical chemistry ...	2	2	—	—	—	—
Organic chemistry	—	—	5	2	—	—
Technical chemistry	—	—	4	2	—	—
Dye industries	—	—	—	—	3	—
Building construction ...	5	—	—	—	—	—
Elements of machinery ...	—	—	5	6	—	—
Electro-chemistry	—	—	—	—	—	1
Political economy	—	—	—	—	3	—
Elementary jurisprudence ...	—	—	—	—	3	3
Microscopic laboratory ...	—	—	—	2	—	—
Chemical laboratories ...	12	12	12	12	24	24
Total	34	34	29	35	33	28

Any extra time at the students' disposal is devoted to practical chemistry, bacteriology, or the chemistry of foods, &c.

The pioneering labours of the German Universities are known to everyone. For pure chemical research they have obtained for themselves a position which places them almost above criticism, and which has made them the envy of the world, insomuch that students flock to them from all countries. In 1897 there were 13,000 students at the Prussian Universities; of these 9 per cent. were foreigners. Each of these students costs the State 31*l.* annually, or about 36,000*l.* In the Prussian high schools during the same year there were 4246 students, of whom 13 per cent. were foreigners, costing the State 14*l.* per head, or nearly 8000*l.* That is to say, in 1897 the Prussian State expended 43,000*l.* on the education of foreigners, many of whom would in all probability enter into trade competition with themselves. Taking the whole of Germany into account it is calculated that no less than 60,000*l.*, or the interest on 2,000,000*l.*, was expended in educating foreigners.

In one respect the German Universities and polytechnics possess an enormous advantage over those of this country—they are not hampered by want of funds. The German Government realises the importance of education, hence the Universities and technical high schools are built upon the most modern principles and fitted up in a style which is little short of perfection. It must not, however, be denied that here we also build

and fit up polytechnics in a manner which leaves little to be desired, so far as the external structure and paint and varnish are concerned. But it so often happens that all the funds have been swallowed up by bricks and mortar, hence there is no money forthcoming for adequate equipment and maintenance,¹ much less for research. The result is, the teaching staff is miserably inadequate and consequently overworked.

The following table, the numbers in which are taken from the reports from University colleges, issued by the Education Department, gives the income and the Government grant for five of our University colleges for the year ending July 31, 1899:—

	Income.	Government Grant.
	£	£
King's College, London ...	42,369	2200
University College, London	35,456	3000
Owens College	47,494	3500
University College, Liverpool	23,792	3000
Mason College, Birmingham	17,864 ²	2700 ²

Contrast this with the German Universities and technical high schools; for our Universities and University colleges, as well as our polytechnics, are but too often without sufficient income.

In 1899 the total income of the University of Berlin was 143,555*l.*; of this large sum no less than 83 per cent. was contributed by the State, while 80 per cent. of the income of the University of Bonn (63,037*l.*) was obtained from the Government. Turning to the technical high schools, that of Berlin, with a total income of 69,077*l.*, received 33,675*l.*; Hanover, total income 25,240*l.*, obtained 15,094*l.*; while Aachen, having an income of 22,998*l.*, received 16,581*l.* from the Government. The teaching staff of the chemistry department—I have not the numbers for the other departments—is also on an equally lavish scale, as the appended table shows:—

	Teaching Staff.	Students.
Heidelberg University ...	10	315
Strasbourg University ...	7	48
Berlin Polytechnic ...	44	278
Stuttgart Polytechnic ...	10	88
Karlsruhe Polytechnic ...	15	139

It has already been mentioned that the technical high schools are taking a more and more leading place; this is shown by the fact that during the last seventeen years the students at the technical high schools have increased 206 per cent., whereas at the Universities the increase is only 12 per cent. In some chemical works preference is given to students who have studied at the technical high schools, one reason being that technical high schools devote much more attention to the teaching of technology. It is estimated that there are in Germany about 4500 trained chemists who have had the full courses at the Universities or technical high schools. But notwithstanding this vast array of expert technical chemists and the preeminent place which German chemical industries have obtained, in chemical industrial circles in Germany there is a widespread feeling that there must be no resting on their oars, but that increased facilities for technical education must be obtained, and it is felt that, unless the Universities devote more attention to technology, the diminution in the number of students will in the course of ten or fifteen years react most unfavourably upon the German chemical industries. How much more so is this the case in our own country, where chemical technology is rarely taught? At our Universities and polytechnics we appoint *one* professor, who has to teach all the branches of chemistry. In Germany there is a professor set apart to teach technology, a

¹ The Technical Education Board of London do their best to remedy defects in equipment, but their funds are not unlimited, and it is not their province to pay for the general upkeep of the institutions.

² This does not include the day training college, which has an income of 5400*l.* and 3679*l.* in the form of grants from the Education Department.

special lecturer for physical chemistry, and very often a professor for organic and another for inorganic chemistry, beside numerous lecturers on different branches of the subject.

The German nation, which has placed its primary and technical education on a sound basis, has been richly rewarded. In 1897 the total production of the German chemical works was 47,391,132*l*. Within the last twenty years many new and flourishing industries have been started, the foundation of which has been entirely due to the results of chemical research. Again, one has only to glance at the appended list, which shows the dividends of some of the larger chemical works, all of which employ a large staff of fully trained chemists, to recognise that science and successful commerce go hand-in-hand:—

Name of works	Dividends		
	1893 Per cent.	1896 Per cent.	1899 Per cent.
Höchst Colour Works ...	28	28	26
Baden Aniline and Soda Works ...	27	26	24
Elberfeld Colour Works ...	18	18	18
Schering and Co., Berlin ...	19	11	12
Nobel and Co., Hamburg ...	21½	13	18
Munich Paper Works ...	15	16	18
Rositz Sugar Works... ..	3	12	13

In this country the Government relies too much upon private initiative and individual generosity. Because nearly all the pioneering labour and many of the most brilliant scientific results of the past century have, so far as this country is concerned, been conducted by private individuals who were fired with the restless and resistless energy of genius, the Government and the manufacturers wrap themselves in an impenetrable armour of self-complacency and blind optimism. Our forefathers, they say, had practically no scientific education, and see how they excelled in invention and obtained the control of the commercial world. Let them, however, remember that in those days the Germans had also practically no scientific education, neither was their empire consolidated as it is at the present moment. So long as the Government refuses to recognise the needs of science, and manufacturers, with fatuous obstinacy, refusing to learn from the experience of other nations, look upon chemists as expensive luxuries, so long will chemical trade remain in the hand of our rivals.

F. MOLLWO PERKIN.

THE GEOLOGICAL SURVEY OF THE UNITED STATES.

IN NATURE for December 27, 1900, we noticed the first and sixth parts of the Twentieth Annual Report of the United States Geological Survey. We have now received the remaining volumes. Part ii., comprising "General Geology and Palæontology," consists of 953 pages with 193 plates. It includes a brief article on the geology of the Philippine Islands, by Mr. G. F. Becker; but as we have since received the full report (noticed further on), we may pass on to the next paper by Mr. J. Nelson Dale, a study of Bird Mountain, Vermont. This mountain, the summit of which is 2200 feet high, lies in the Taconic Range, and consists of about 500 feet of Ordovician grit and conglomerate interbedded with muscovite-schist, and underlain by similar schist with beds of quartzite. The author discusses the origin of the mountain, the features of which have been largely sculptured by glacial action. The Devonian fossils from south-western Colorado, constituting the fauna of the Ouray Limestone, are described by Mr. George H. Girty. Although by some authorities regarded as Carboniferous, Mr. Girty considers that the fauna indicates late Middle or early Upper Devonian. Varieties of *Spirifer disjunctus* occur, together with numerous other fossils.

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A preliminary paper on the geology of the Cascade Mountains in Northern Washington is contributed by Mr. Israel C. Russell. The rocks comprise granite, various schists, greenstone and serpentine of unknown age, and also a great extent of slightly altered and unaltered sedimentary strata, mainly Cretaceous and Tertiary, with some possibly of Jura-Trias age. The granites and allied rocks are usually jointed in a conspicuous manner. The influences of these joints on the rugged spires and cathedral-like forms resulting from weathering are among the most characteristic details in the magnificent scenery of the Cascade Mountains. The structure of the range is highly complex. This is briefly described, and fuller particulars are given of the striking effects of glaciation.

Mr. Lester F. Ward is the author of an elaborate essay on the older Mesozoic floras of the United States, Triassic and Jurassic; and Mr. David White deals with the stratigraphic succession of the fossil floras of the Pottsville formation in the southern anthracite coal-field of Pennsylvania. The plants of this Carboniferous formation exhibit a rapid development, and a series of changes or modifications, which are considered of high stratigraphic value.

Part iii. deals with the "Precious-metal Mining Districts." The Bohemia mining region of western Oregon is described by Mr. J. S. Diller. It is situated at an altitude of between 4000 and 6000 feet above the sea, along the crest of the Calapooya Mountain, and upon both slopes. The mountain is composed of lavas like those of the Cascade Range. Generally the sheets of lava are very irregular. The lava filling the throat of a once active volcano has in the case of the Cougar Rock made a prominent peak, while in Bear Bones Rock it presents a conspicuous columnar structure. The streams have cut deep, narrow valleys, approaching canyons in character. These expose rocks to a depth of more than 2000 feet—comprising lavas (chiefly andesites), vein matter and stratified fragmental volcanic material. It is probable that volcanoes were active in Eocene times, and continued so during the Miocene period. The veins lie along narrow, irregular joint-planes in which there has been much crushing of rock material. The principal gangue is quartz, containing at a depth much pyrites and other sulphides in which gold occurs; while near the surface the gold is native, finely filamentous and distributed through iron-stained quartz. The output in this region has been chiefly from one mine during the last few years. Mr. F. H. Knowlton contributes an account of the Miocene plants of the Cascade Range.

The gold and silver veins of Silver City, De Lamar, and other mining districts in western-central Idaho are reported on by Mr. Waldemar Lindgren. The area includes four types of scenery: (1) the Snake River valley, extensive arid plains underlain by Neocene lake-beds with intercalated flows of basalt, which are cut into to a depth of from 400 to 1000 feet; (2) the Owyhee Range, a steep granite ridge covered by broad areas of Neocene lavas; (3) a great central granite region north of the Snake River, with bordering sedimentary rocks, probably Palæozoic, showing extensive contact metamorphism: the whole described as a veritable labyrinth of ridges and peaks separated by sharply-cut canyons, the higher ridges attaining elevations of 12,000 feet, and evidently an old plateau with an intricate and deeply-cut drainage system; and (4) a more recent plateau of the Columbia lava flows, of Miocene age.

The mineral deposits of the great granite area are fissure veins, containing gold and silver in a quartzose gangue. The adjoining sedimentary areas carry either veins or contact deposits of irregular shape, generally containing silver, lead, zinc and copper. The Tertiary volcanic rocks contain in places gold and silver veins